PROPULSION DIRECTORATE

Monthly Accomplishment Report
August 2005

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NEW INSTRUMENTATION DEVELOPED FOR F135 TURBINE BLADE MEASUREMENTS: F135 Endurance Engine Tests revealed excessive thermal stress on the F135's high pressure turbine (HPT) blade platforms, and heat transfer predictions are inadequate to investigate this complex unsteady 3-D flow region. To help solve the problem, researchers in the Heat Flux Instrumentation Laboratory of AFRL's Propulsion Directorate have developed unique advanced thin film heat transfer instrumentation. New double-sided, platinum thin film gauge arrays have been designed and fabricated to measure surface heat flux in the F135 HPT blade platform region. The non-intrusive sensors are made of 600 Angstrom thick platinum film patterns deposited onto both sides of a flexible 50 micron thick sheet of polyimide. Researchers are able to apply the double-sided film arrays to the HPT platform surface without causing disruption to the flow surface and without any machining of the test blade. The technique provides a non-intrusive measurement in a critical and complex flow area. These sensors are being tested for the first time in a fully-rotating, transient, HPT rig test in AFRL/PR's Turbine Research Facility (TRF) at Wright-Patterson AFB, Ohio. The traditional measurement technique uses single-sided gauges and a semi-infinite heat transfer calculation that is insufficient for the thin metallic platform heat transfer problem. The new double-sided manufacturing technique allows capture of the correct boundary conditions for more complex, 3-D heat conduction problems, which are prevalent in cooled turbine hardware. This instrumentation provides a new capability to the TRF and a means to investigate immediate challenges for the Joint Strike Fighter's F135 engine and other advanced military propulsion systems. (Dr. R. Anthony, AFRL/PRTT, (937) 255-6768)

F135 Endurance Engine Tests revealed excessive thermal stress on HPT blade platforms

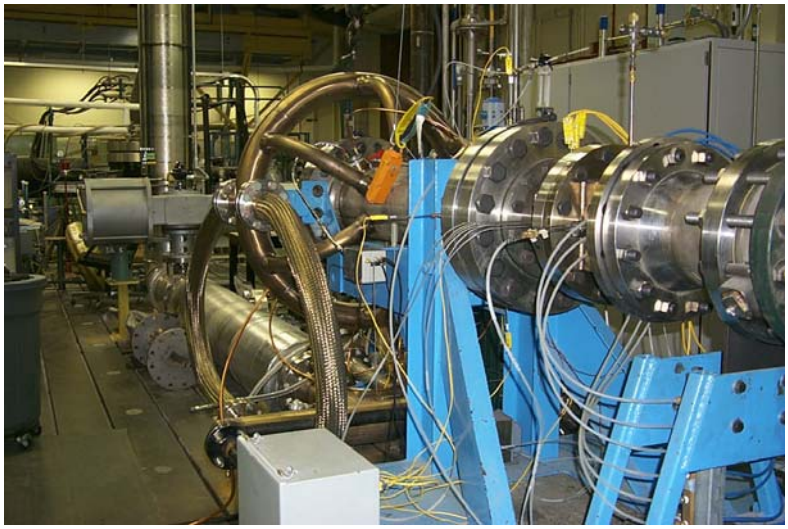

New, double-sided, platinum thin film gauge arrays have been designed and fabricated to measure surface heat flux in the F135 HPT blade platform region

DR. GORD SELECTED AS AFRL FELLOW: The Propulsion Directorate's Dr. James R. Gord was recently honored as a new AFRL Fellow. He is one of only seven individuals to receive this prestigious honor in 2005. Dr. Gord and the other new AFRL Fellows were honored at the 8th Annual AFRL Fellows Award Banquet held on 16 August 2005 at the National Museum of the United States Air Force at Wright-Patterson AFB, Ohio. Dr. Gord leads the development and application of optical measurement techniques for the characterization and improvement of advanced propulsion and fuel systems as Leader of the Combustion and Laser Diagnostics Research Complex (CLDRC). In the CLDRC, his efforts are focused on 1) developing and demonstrating advanced optical measurement techniques, 2) hardening those techniques for application to real-world problems of significance to the Air Force, and 3) developing and fielding sensor platforms based on these technologies for on-board monitoring and control. To date, his work has produced five patents, 56 peer-reviewed journal articles, and 345 conference papers and presentations, 50 of which were delivered upon invitation. Dr. Gord also serves as an adjunct professor for Miami University, Purdue University, and St. Louis University. He has been frequently honored over his career, and some of the more significant awards he has received include: AFRL's Award for Outstanding Scientific and Technical Achievement by a Team (2004), Dayton's 40 Superachievers Under 40 (2004), Honorable Mention for the USAF Basic Research Award (2002), AFRL's Award for Outstanding Scientific and Technical Achievement by an Individual (2001), AFRL/PR Scientist of the Year (2001), Affiliate Societies Council of Dayton Outstanding Engineers and Scientists Award (2001), the S.D. Heron Award (2000), and the Ernest C. Simpson Award (1996). (Dr. R. Hancock, AFRL/PRTC, (937) 255-6814)

Dr. Jim Gord is the latest PR scientist to be named an AFRL Fellow

HIGH SPEED TESTING CAPABILITIES ENHANCED: The Propulsion Directorate's Research Cell 18 at Wright-Patterson AFB, Ohio, has been elevated to a world-class continuous flow scramjet component research facility with the completion of a heated air system upgrade. A number of checkout runs have already been performed showing that the system (i.e., piping, instrumentation, and control system) is operating to specification. The new system is capable of providing a continuous source of furnace heated air (indirect heat) to any of the three tunnels in

the laboratory at conditions up to 1100°F at 750 psia. With the completion of this air system upgrade, the supersonic combustion rig in Research Cell 18 will now be capable of its full simulation capability of flight Mach numbers from 3.5 to 5 at flight dynamic pressures between 500 and 2000 lb_f/ft^2. This increased capability, combined with new combustor hardware to be installed by the end of 2005, will allow PR's Aerospace Propulsion Division (AFRL/PRA) to begin exploring alternate scramjet combustor ignition devices, active control methodologies, diode laser based diagnostic techniques, and fuel injection and mixing techniques in a realistic, reacting flow environment. (LtCol J. Haralson, AFRL/PRA, (937) 255-7105)



Test Cell 18 has been elevated to a world-class continuous flow scramjet component research facility through an upgrade to the heated air system

PRE-SWIRLER DESIGNED TO AID IN TESTING OF GLOBAL HAWK TURBINE: Later this year, a three-stage low pressure turbine (LPT) test will be performed in the Propulsion Directorate's Turbine Research Facility (TRF) at Wright-Patterson AFB, Ohio. This three-stage LPT is from a Global Hawk AE3007 engine, and it will be run in the TRF to assess the potential for lapses in performance at high altitudes. In the actual engine, the inlet flow angle into the LPT is set by the blade of the high pressure turbine (HPT). However, in the TRF it is not possible to run both the HPT and LPT at the same time, so a pre-swirler is required to set the proper inlet flow angle for the LPT. Consequently, a pre-swirler was designed in-house by AFRL/PR personnel in order to facilitate testing. Several years ago this would have been a challenge because this in-house design capability did not exist; however, ongoing development of in-house design and analysis tools made this design work possible. In addition to the requirement to match the flow angle, the number of pre-swirlers required needed to be as low as possible in order to reduce fabrication costs. After several iterations through the design system, which includes 2-D and 3-D analyses, the required inlet flow angle to the engine LPT was achieved. The successful completion of this design work signifies a milestone for PR personnel, since the pre-swirler is the first vane designed by PR personnel to be fabricated and high speed tested in the TRF. (Mr. P. Koch, AFRL/PRTT, (937) 255-7319 and Dr. J. P. Clark, AFRL/PRTT, (937) 255-7152)

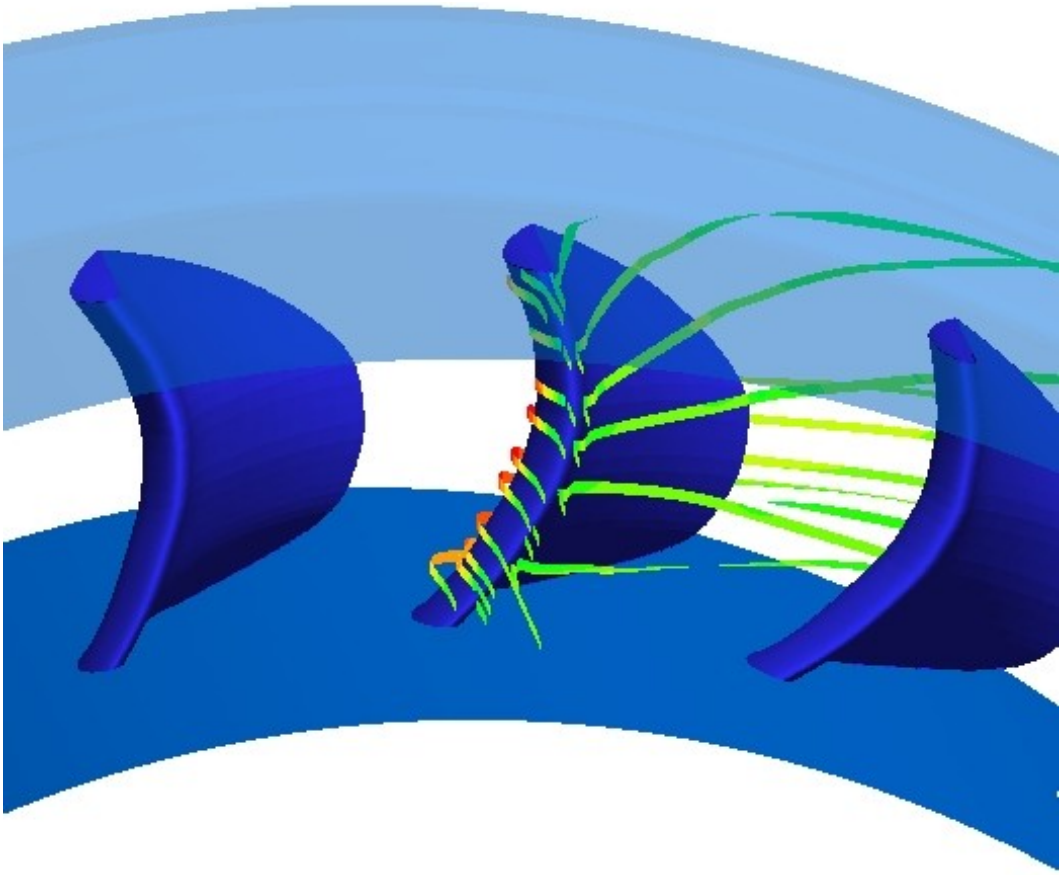


Figure showing the flow through the pre-swirler using stream traces. Note the 3-dimensional nature of the design required to match the exit flow angle of the rotating HPT.

Ms. Jo Ann LaRue recently received the Exemplary Civilian Service Award

MS. LARUE RECOGNIZED FOR LEADERSHIP OF ANALYTICAL CHEMISTRY LAB: The Propulsion Directorate's Ms. Jo Ann C. LaRue recently received the Exemplary Civilian Service Award. Ms. LaRue was recognized for her distinguished service as a research chemist in the Propellants Branch (AFRL/PRSP) of PR's Space and Missile Propulsion Division at Edwards AFB, California, from August 2001 to February 2005. Ms. LaRue has led the Propellant Branch's analytical laboratory since August 2001, and during this time, she has compiled an outstanding record of high quality, responsive service to her customers. In addition to working in support of PR, her team has provided services to the Air Force Flight Test Center (AFFTC), NASA Dryden Flight Research Center, NASA Kennedy Space Center, and Boeing-Rocketdyne. She has demonstrated the ability to affect productivity and quality

improvements through modernization in equipment and procedures, and she is widely recognized for her expertise in analytical chemistry. She is also a leader outside the workplace, serving as the chair of the Mojave Section of the American Chemical Society (ACS), developing an ACS program for placing high school students with interest in chemistry in summer jobs in the Antelope Valley, and implementing an Educational Partnership Agreement with a local high school to transfer analytical equipment, provide technical assistance, and mentor students. (Dr. R. Channell, AFRL/PRSP, (661) 275-5762)

MR. SUTTON RECOGNIZED FOR EXCELLENCE IN PROGRAM MANAGEMENT: The Propulsion Directorate's Mr. Alan M. Sutton recently received the Exemplary Civilian Service Award. Mr. Sutton was recognized for his distinguished service as a physicist in the Engine Branch (AFRL/PRSE) of PR's Space and Missile Propulsion Division at Edwards AFB, California, from January 2001 to February 2005. Mr. Sutton is a highly experienced program manager who has frequently been called upon to organize and lead high value programs and special projects. He also has a well-earned reputation as a "repair" specialist for troubled programs, and is utilized in that capacity by his own branch as well as the Space and Missile Propulsion Division. In addition, his experience as the Advanced Reusable Rocket Engine (ARRE) program manager has established him as the laboratory's expert on hydrogen peroxide fueled engine performance, logistics, and testing. Mr. Sutton's other areas of expertise include uncertainty analysis and failure analysis investigations. His exemplary efforts in the areas cited above have contributed significantly to the nation's space launch and space maneuvering mission. (Dr. S. Phillips, AFRL/PRSE, (661) 275-5198)

Mr. Alan Sutton recently received the Exemplary Civilian Service Award